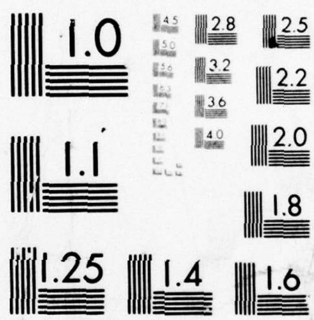
AD-A042 930 OFFICE OF NAVAL RESEARCH LONDON (ENGLAND) F/G 5/2
EUROPEAN SCIENTIFIC NOTES NUMBER 8-14,(U)
JUL 54 E EPREMIAN

UNCLASSIFIED ESN-8-14 NL

| OF |

AD A042930

END
DATE FILMED
9-77
DDC




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

241

OFFICE OF NAVAL RESEARCH

LONDON

(1)

B.S.

(6) EUROPEAN SCIENTIFIC NOTES Number 8-14,

(14) ESN-
No. 8 - 14

AD A 042930

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

(11) 15 July 1954

(10) E. Epremian

Distributed by the Office of Naval Research
Washington 25, D. C.

(12) 11p.





AMERICAN EMBASSY LONDON, ENGLAND



265 000

OFFICE OF NAVAL RESEARCH
London

# EUROPEAN SCIENTIFIC NOTES

15 July 1954 8 - 14



AMERICAN EMBASSY LONDON, ENGLAND

OFFICE OF NAVAL RESEARCH
London

EUROPEAN SCIENTIFIC NOTES

15 July 1954 No. 8 - 14

## ACCELERATORS AT THE NATIONAL UNIVERSITY, CANBERRA, AUSTRALIA

The present status of the accelerator program at the Australian National University was described recently in a colloquium given by Prof. E. W. Titterton (Canberra) at University College, London.

The major program at present involves the construction of a proton synchrotron which will produce energies in the range of 10 - 15 Bev. The design of this accelerator has been constrained by the following practical considerations:

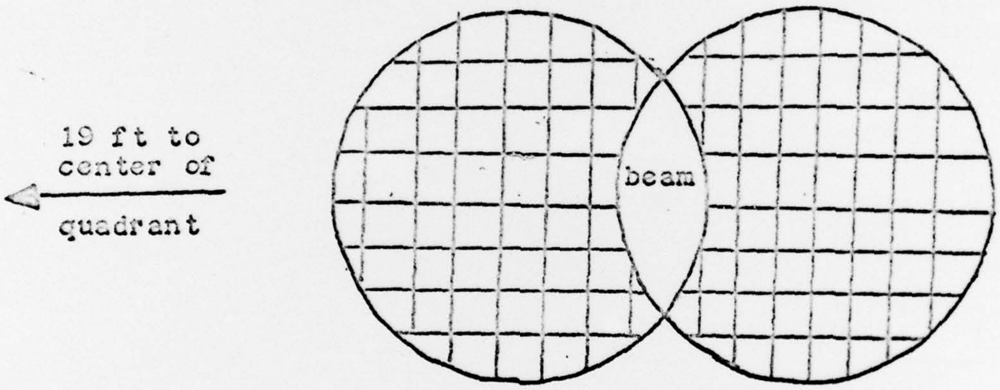
(1) The limit of the power that can be installed for some time is 1.25 megawatts.
(2) There is on hand a 132" magnet which was originally intended for a synchrocyclotron.
(3) The building available has a maximum width of some 40 feet.

With these constraints in mind it has been decided to use the 132" magnet as a homopolar generator to power an air-core synchrotron. Considerable time was spent in the evaluation of the possible use of strong focusing in this accelerator but it was finally decided that the advantages would not be worth the effort involved.

The rotating part of the homopolar generator will be four steel discs 132" in diameter each weighing 22 tons. Two of the discs will rotate in each of the opposite directions and the electromotive force of all four will be placed in series. At the start of the excitation of the accelerator the kinetic energy in the four discs will be $\frac{1}{2}I\omega^2$ where $\omega$ is related to the frequency of rotation which is 900 rpm. This homopolar generator magnet will occupy about half of the building and will be separated from the accelerator by a shielding wall through which cables will carry the

1,500,000 amperes supplied to the accelerator by the homopolar generator. When excitation of the accelerator is started by starting jets of liquid sodium at the edge and center of the discs, the current in the circuit is zero and so no difficulty is anticipated at this point. The steel in the magnet for the generator weighs 1400 tons and the coils consist of about 30 tons of aluminum supplied with a central hole for water cooling in 1000 ft lengths.

The magnetic field for the accelerator will be supplied by an air-core coil of cross section as shown in the accompanying figure.




The circular cross sections are approximated by a number of turns of cable. There will be four quadrants in the accelerator. The energy storage in the field will be $\frac{1}{2}Li^2$ and with maximum current (i) this energy will approximate the energy stored in the homopolar discs before the start of the excitation of the accelerator field. The radius of curvature of the quadrants will be 19 ft.

The time required for acceleration will be 1.25 seconds; however, because of the low installed power of 1.2 megawatts, the repetition rate can only be 1 pulse in 8 minutes. It is not planned, because of possible switching difficulties, to feed the energy in the magnetic field of the accelerator back into the discs of the homopolar generator.

A 32" magnet has been used to test the practicality of building and operating a homopolar generator. A 30" stainless steel disc was rotated in the field and jets of mercury were used to make electrical contact at the center and edge of the disc. With this model, 100 amperes of current were drawn from the generator.

The 32" magnet is now being used in the construction of an 8 Mev cyclotron which it is planned to use as the injector for the large accelerator. It is planned to finish the construction of this machine by January 1955, and it is hoped to obtain currents of the order of 5 milliamperes from it so that a large pulse of current will be available and may be accelerated in the proton synchrotron. With 1 pulse only every 8 minutes it is very desirable to make the total charge in the pulse as high as possible. It is expected that the cost of the proton synchrotron and associated equipment will be less than £500,000.

Other accelerators at Canberra include a 1.2 Mev Cockcroft-Walton set made by Philips which produces a beam of 1 milliampere and has already been used in a number of experiments on photodisintegration. A 600 kev Cockcroft-Walton set is being constructed at Canberra and also a 33 Mev synchrotron, which is at present in operation at Harwell, will very shortly be moved to Canberra where it will be put into operation, according to present plans, by January 1955.

THE SUPERCONDUCTIVITY OF NIOBIUM NITRIDE

The Low Temperature Group of the Physical Society of London met with German scientists active in this field at Göttingen early in May. At this meeting Prof. E. Justi and Dr. G. Lautz (Braunschweig) discussed some recent results which help to explain the previously reported discrepancies in the superconducting transition temperatures of different samples of niobium nitride. It appears that the pure substance has a superconducting transition temperature between 14° and 16°K. The transition point increases upon the addition of very small amounts of metallic impurities. In recent experiments molybdenum and tungsten were added in various amounts up to 10 atom per cent. In accordance with the previous results in Justi's laboratory, such impure samples can have transition temperatures as high as 23°K.

## THE PARAMAGNETIC SUSCEPTIBILITY OF OXYGEN IN CLATHRATES

At the low temperature discussion referred to in the previous paragraph Dr. A. H. Cooke (Oxford) discussed recent observations on the paramagnetic susceptibility of oxygen in quinol clathrates down to 1°K, which suggest that at low temperatures the molecules of oxygen are hindered in their rotation. The preparation and properties of various quinol clathrates have been actively pursued in different laboratories in Oxford during the past few years (cf. e.g. ESN 8, 18 (1954)). During crystallization foreign molecules, such as oxygen, can be trapped in holes in the clathrate lattice and these trapped molecules appear to behave like a free gas at room temperature. The susceptibilities were measured between 20°K and 1°K by studying the influence of the specimen on the mutual inductance of a pair of coils. The measurements were performed with samples in which 60 per cent of the holes were filled either with practically pure $O^{16} - O^{16}$ or with a mixture of 11 per cent $O^{16} - O^{18}$ and 89 per cent $O^{16} - O^{16}$. The measured susceptibility was the same for both specimens in the entire temperature range and agreed within experimental error with the calculated susceptibility of $O^{16} - O^{16}$ down to 2°K.

## THE REACTIVITY OF ANTHRACENE WITH FREE RADICALS

The kinetics of the addition of t-butyl radicals to anthracene and some of its simple derivatives is being investigated by Dr. E. C. Kooyman and his collaborators (Shell Laboratories, Amsterdam). The addition occurs in the 9 and 10 positions and the rate of the reaction can be conveniently followed by means of UV spectrophotometry, since it involves the disappearance of the characteristic strong anthracene absorption band. The reactions are performed on solutions of 0.5 mg of the aromatic in 25 cc cyclohexane and the products are of the type RAR and RAAR, where R and A stand for the t-butyl group and for the anthracene skeleton respectively.

The novel compound, 2,2'-azoisobutane, which was recently shown to be a convenient source of t-butyl radicals (cf. Rec., 72, 11 (1953)), is being used to great advantage in these studies.

The reactivity of the 9 and 10 positions in three anthracene derivatives, compared to those of anthracene as the standard, are as follows:

| Compound | $C_9$ | $C_{10}$ |
|---|---|---|
| Anthracene | 1 | 1 |
| 9-Methyl anthracene | 2 | |
| 9,10-Methyl anthracene | 0.08 | 0.08 |
| 9-Chloro anthracene | 1.7 | |

These results agree well with predictions based either on calculations of the delocalization energy or on the free valence numbers. Analogous experiments now in progress on azulenes and other non-alternating hydrocarbons will permit a choice between these two theoretical treatments.

## HEATS OF MIXING OF PARAFFINS WITH CYCLOPARAFFINS

The heat of mixing of two binary systems consisting of a paraffin and a cycloparaffin with the same number of carbon atoms was recently investigated by Prof. W. Jost and Mr. Brand (Göttingen). It is of interest that they find a temperature dependence in both of these systems which is great enough to enable one of them to pass from exothermic to endothermic heats of mixing.

A twin calorimetric technique was used, with a mercury seal in the mixing chamber, similar to that described recently by G. Scatchard. Vigorous stirring is carried out by rotation-oscillation of the calorimeters from the outside over ±180° arcs. The two systems investigated were equimolar mixtures of n-heptane and methyl cyclohexane, and n-decane with trans-decalin. The temperature range investigated so far is 0° - 40°C. The decane system is exothermic to the extent of 8 cal/mole at 0°C, passes through zero at 15°C and is endothermic with 5 cal/mole at 30°C. The points for the heptane system lie on a parallel straight line approximately 10 cal/mole more exothermic. This system would thus show no heat of mixing at about 45°C.

## STORED ENERGY IN DEFORMED METALS

Since the early classic work of G. I. Taylor on the energy stored in cold-worked metals, a number of investigators have studied this problem more intensively

using refined techniques which have been subsequently developed. At a recent lecture to the Institute of Metals in London, Dr. W. Boas (Tribophysics Laboratory, Melbourne) described his research over the past three years on this subject.

The fundamental aim of the Australian work is to investigate the cold-worked state and determine the roles played by various lattice defects such as interstitial atoms, vacancies, dislocations, and stacking faults. The stored energy measurements are eventually to be supplemented by X-ray diffraction studies of the structure of deformed metal utilizing the approach and techniques developed by Averbach and Warren.

In the stored energy study Boas has used the differential thermal analysis method whereby two specimens, one annealed and the other deformed, are heated at a constant rate but maintained at a small constant difference in temperature. The amount of electrical energy required by the resistance heating elements to maintain this constant temperature difference is readily measured and provides a means of determining the stored energy. Boas emphasized the extreme experimental difficulties in this work; for example, the two thermocouples (one connected to each specimen) must be identically arranged in the apparatus otherwise a spurious "energy" will be measured.

The first experiments were conducted on copper deformed in torsion so that the results might be compared with those of Taylor as a preliminary check. As would be expected the amount of stored energy increased with the amount of cold-work imposed, and the temperature at which this energy was released decreased with increasing amounts of deformation. Surprisingly, however, the values for the stored energy were about one-half those reported by Taylor. Further research disclosed the fact that this discrepancy is based on differences in the chemical composition. In the Australian experiments, copper containing 0.0065% P differed significantly from that with 0.0021% P; the former has a higher recrystallization temperature and therefore a higher temperature at which the energy is released. Analysis of the material used in Taylor's experiments showed an arsenic content of 0.45% which explained the large difference from Boas' results.

Following this work, attention was devoted to a metal with a higher recrystallization temperature, namely nickel. With this material it appears that stored energy is released at two temperatures, the first of which (lower) is associated with the elimination of vacancies, i.e. recovery. The second release of energy is due to recrystallization. Parallel observations of changes in electrical resistivity, density, and hardness are in accord with the two stages of the process.

Four copper specimens have been fatigue stressed in compression and tested for stored energy. A previous preliminary study of fatigued copper gave the rather unusual result of a negative stored energy (Journal of Metals 5, 1558 (1953)). Boas, however, has found in his work that the fatigued specimens had a small but positive stored energy of 0.05 cal/gm.

DEVELOPMENT OF SONGS BY BIRDS REARED IN ISOLATION

In experiments which are soon to be published in Zeitschrift für Tierpsychologie, Dr. Franz von Sauer and Prof. Otto Koehler, Zoological Institute, University of Freiburg, Germany, have recorded at regular intervals the songs of birds reared in isolation so that they do not at any time hear the sounds produced by other birds. Analysis of the recordings shows that the different birds of the same species all develop the same calls. As age increases the songs become more and more complex; the developmental sequence is similar for all birds. The fully developed songs of different birds contain the same elements and the elements occur in similar patterns. Dr. Sauer and Prof. Koehler point out similarities between the development of songs in birds and the earliest stages of language development in the human infant.

DEVELOPMENT OF OPTOKINETIC RESPONSE IN THE CHICK

In a series of experiments on the development of the optokinetic response in the chick, Dr. George Birukow and M. Simon, Zoological Institute, University of Freiburg, have shown that experience in a normal lighted environment is important for the development of the response of head movements to a moving striated pattern. When first tested animals reared in darkness or in a homogeneous light field do not behave in the same fashion as animals reared in a

normal environment; but they develop the normal response after experience in light. In the young chick eye-movements in response to a moving striated pattern are at first binocularly controlled, i.e. with one eye covered a response is elicited by movement of the pattern in either direction. As the chick grows older this response becomes more and more controlled by monocular stimulation, i.e. by movement of the striated pattern in the direction from the seeing towards the non-seeing eye.

## PERSONAL NEWS ITEMS

Dr. K. Hauffe, formerly with the Max Planck Institut für Eisenforschung, Düsseldorf, Germany, is now head of the solid state physics division at the Central Institute for Industrial Research, Blindern-Oslo, Norway.

Dr. H. Pick of Göttingen has been appointed to the newly created Chair of Applied Physics at the Institute of Technology in Stuttgart.

Dr. E. Wicke of Göttingen was honored with the Fritz Haber Medal of the German Bunsen Society at their recent annual general meeting in Bayreuth.

Dr. F. C. Frank of the H. H. Wills Laboratory, University of Bristol, has been named to a newly created Chair in Physics at that University.

Dr. Basil F. J. Schonland, head of the Bernard Price Institute of Geophysical Research in the University of the Witwatersrand, South Africa, has been appointed Deputy Director of the Atomic Energy Research Establishment at Harwell. Dr. Schonland will assume his new position towards the end of this year.

## TECHNICAL REPORTS OF ONRL

The following reports have been forwarded to ONR, Washington. Copies may be obtained by addressing requests to the Commanding Officer, Office of Naval Research Branch Office, Navy No. 100, c/o Fleet Post Office, New York, N.Y.

ONRL-40-54 "Organic Chemical Research in Israel" by J. C. Sheehan

| | |
|---|---|
| ONRL-42-54 | "The Harwell 600 Mev Proton Linear Accelerator" by J. R. Richardson |
| ONRL-44-54 | "Annual General Meeting of the Ergonomics Research Society" by W. D. Neff |
| ONRL-45-54 | "The Liverpool School of Tropical Medicine" by T. K. Ruebush |

Prepared by the Scientific Staff
Edited and submitted by Dr. E. Epremian
Deputy Scientific Director

P. S. CREASOR
Captain, U.S.N.
Assistant Naval Attache for Research